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(54) REFORMED MEAT PRODUCTS

(71) We, RALSTON PURINA COMPANY, of Checkerboard Square, St. Louis, Missouri 63188, United States of America, a corporation organized under the laws of Missouri, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a reformed meat product and to a process for its preparation. As used herein, the term "reformed meat product" means a product comprising meat which has been treated so as substantially to destroy its natural structure and which is then re-formed, either by mechanical processing or by admixture with other material to produce a product which, in appearance, texture or mouthfeel resembles natural meat.

In many cuts of meat, the proportion or kind of connective tissue in relation to the content of fat and/or juices is such that the cooked meat lacks the masticating properties, taste, texture, juice retention, mouthfeel and other organoleptic properties which provide the attractiveness of high quality meat; such cuts of meat are regarded as "low quality". These meats are often tough to eat or, if tenderized by comminution, have too little chewiness; on the other hand, if more texture is provided, they generally lack the appearance, stability and juice retention of natural meat. A product having a low juice retention has a very much reduced cooked yield.

Accordingly, such low quality meats lack the highly fibrous, but tender, juice-stable and structured properties of good quality cooked natural meat.

We have now discovered how such inferior quality meat can be processed to produce a product of much improved appearance, mouthfeed and juice retention and which is, therefore, far more acceptable to the consumer. The invention can also used to process meat trimmings, offal (such as heart meat) and by-product meats which, although of good nutritional value, may, by reason of their appearance, be difficult to sell. Also, if desired, the invention can be applied to higher quality meats which cannot be disposed of as such.

The invention provides a reformed meat product which has the combination of physical and organoleptic properties of good quality whole meat.

Thus, the present invention consists in a reformed meat product having a pH value which (i) where the meat is not of fish origin, is from 5.8 to 6.4, (ii) where the meat is of fish origin, is from 6.3 to 6.8, or (iii) where the meat is a mixture of fish and of non-fish origin, is an average of (i) and (ii) in proportion to the weight ratio of non-fish and fish, which product comprises:

(a) a raw meat mass, the connective tissue, if any, of which has been substantially destroyed, preferably in an amount of from 20 to 70% by weight;

(b) an emulsion of fat, water and a heat-coagulable vegetable protein;

(c) fibrous textured vegetable protein, preferably in an amount of from 15 to 30% by weight, and

(d) a non-heat-coagulable vegetable protein, preferably in an amount of from 1 to 5% by weight.

The invention further consists in a process for preparing said reformed meat product, which comprises forming an emulsion of fat, water and a heat-coagulable vegetable protein, mixing said emulsion, a raw meat mass (the connective tissue, if any, of which has been substantially destroyed), fibrous textured vegetable protein and a nonheat-coagulable vegetable protein, and, if necessary, before or after mixing adjusting the pH of said emulsion and/or of said fibrous textured vegetable protein to the value required to produce a product having said pH value (i), (ii) or (iii).

The raw meat mass employed in the present invention comprises meat which has been finely divided, comminuted or

otherwise treated so as substantially to destroy any connective tissue. The meat employed will, as explained above, generally be a poor quality meat and it is a particular advantage of the present invention that such poor quality meat may be employed to provide a product which is acceptable to the consumer; however, of course, meats of better quality may be employed in the invention, should this be desired. As used herein, the term "meat" refers to the edible, and particularly the fleshy, parts of animals, particularly mammals, birds and fish; specific examples are beef, pork chicken, mutton and tuna. Poorer quality meats of this type will generally contain from 20 to 60% by weight fat. In addition to the meat, the raw meat mass may contain various salts of the type conventionally added to meats. Such salts may aid in the destruction of connective tissues, maximize the water and/or fat binding efficiency or simply improve the flavour. Examples are salts of aminoacids, salts of phosphoric acid and common table salt (sodium chloride). It is preferred that these salts, if present, should be employed in an amount sufficient to provide from 0.5 to 2% by weight of the final product.

The pH of the raw meat mass will vary depending upon the nature of the meat employed; in the case of non-fish meats, the pH will generally vary from 5.4 to 6.4; however, in the case of fish and of mechanically deboned meats, the pH may run as high as 7.0. The pH of the raw meat mass may also be affected by any salts added.

The raw meat mass is mixed with fibrous textured vegetable protein, with a fat emulsion containing a heat-coagulable vegetable protein and with a non-heat-coagulable vegetable protein. We prefer that the emulsion and the fibrous textured vegetable protein should first be mixed to form a textured vegetable protein matrix.

The fibrous textured vegetable protein is preferably in the form of protein filaments; these may be prepared by heating a confined flowing aqueous slurry (preferably having a solids content of at least 20% by weight) and comprising a proteinaceous material and optionally a cellulose and/or carbohydrate by-product from the processing of protein-containing vegetable materials or grains. This process is preferably carried out in a tubular heat exchanger. Processes of this type are described in U. S. Patent Specifications No. 3,911,159, No. 3,821,453, No. 3,662,671, No. 3,662,672 and Reissue No. 28,091, and in U.K. Patent Specifications No. 1,269,769. No. 1,412,801 and 1,422,436.

The emulsion employed in the present invention comprises water, fat and a heat-coagulable vegetable protein. The fat is preferably employed in an amount of from 30 to 60% by weight, more preferably about 50% by weight, based on the weight of the fibrous textured vegetable protein. The type of fat is not critical and the fat can be of animal (including fish) or of vegetable origin. Examples of suitable fats are tallow, lard, soybean oil, cottonseed oil, corn oil, flaxseed oil, peanut oil and rapeseed oil. The presence of fat serves to inhibit any appreciable and undesirable softening of the fibrous textured vegetable protein at the appropriate pH and improves the texture of the product at a least cost formulation. The coagulable vegetable protein is preferably a vegetable protein isolate and should be employed in an amount sufficient to stabilize the fat in the emulsion. Typical amounts of coagulable vegetable protein are from 7.0 to 20.0% by weight, based on the weight of the fat. Examples of coagulable vegetable protein isolates are protein isolates from the oilseeds, particularly soybeans, cottonseeds, flaxseeds, peanuts and rapeseeds; however, protein isolates from other vegetables may also be employed. These isolates form an irreversible gel upon heat-setting and are capable of forming stable emulsions with fat, even in the presence of salt.

The pH of the emulsion and/or of the fibrous textured vegetable protein, preferably of the latter, is adjusted to give a final product of the appropriate pH. We have discovered that, if the pH of the emulsion or, particularly, of the fibrous textured vegetable protein, is adjusted to give a final product having the appropriate pH, the juice retention and the compatibility of the fibrous textured vegetable protein with the meat are both improved. A pH which is too low will reduce compatibility, whereas a pH which is too high will unduly soften the fibrous textured vegetable protein, detracting from the chewiness of the product. Fish products, which are required to be somewhat softer than those of non-fish origin, should have a rather higher pH, in general, than should a product of nonfish origin. The exact pH to which the fibrous textured vegetable protein is raised will, of course, depend upon the other constituents of the product, as will be explained in more detail hereafter.

Where the fibrous textured vegetable protein and the fat emulsion are to be mixed in a preliminary step to produce a protein matrix, they are preferably mixed in a mixer having a minimum cutting action, so as not to destroy the fibrous nature of the fibrous textured vegetable protein.

The final component of the reformed meat product is a non-coagulable vegetable protein, preferably a vegetable protein isolate. It is used in an amount sufficient to absorb residual water and fat, which are released from the low quality meat upon cooking. In general, we prefer to employ the non-heat-coagulable vegetable protein in an amount of from 1 to 5% by weight of the reformed meat product, more preferably from 2 to 10% by weight of the weight of the raw meat mass. Like the heat-coagulable vegetable protein, the non-heat-coagulable vegetable protein is preferably in the form of a protein isolate and is preferably derived from an oil-seed, e.g. soybeans, cottonseeds, flaxseeds, peanuts or rapeseeds, although other sources of vegetable protein may also be employed. The non-heat-coagulable protein may be distinguished from the heat-coagulable protein in that the former does not, unlike the latter, form a stable gel in the presence of salt but will, rather, remain more solid and thus has the ability to "mop up" or absorb fat and water, rather like a sponge. The heat-coagulable and non-heat-coagulable proteins may also be distinguished by their NSI (nitrogen solubility index), a measure of the amount of protein able to "dissolve" or disperse in water, heat-coagulable protein isolates have a high NSI, whereas non-heat-coagulable protein isolates have a low NSI. In general, non-heat-coagulable protein isolates will have been subjected, during their preparation, to heat treatment, whereas undue heat will normally have been avoided during the treatment and production of heat-coagulable protein isolates.

We prefer that the fibrous textured vegetable protein and the fat emulsion should first be mixed to produce a protein matrix, after this, the raw meat mass, protein matrix and non-coagulable protein are mixed in any conventional meat mixing apparatus. Alternatively, the fibrous textured vegetable protein may first be mixed with the comminuted raw meat mass, after which the fat emulsion and non-heat-coagulable vegetable protein are added. The mixer employed is preferably operated with a minimum cutting action, so as to avoid any destruction of the fibrous structure of the fibrous textured vegetable protein. After mixing, the product is preferably passed through a mincer having a plate with perforations of such a size as not substantially to destroy the fibrous nature of the fibrous textured vegetable protein. In general, we prefer that the plate should have perforations of at least 0.5 inch, more preferably at least 0.75 inch; most preferred are perforations of about 1 inch. The mincer serves to ensure complete mixing of the product. After passage through the mincer, if employed, the product can, if desired, be moulded and/or cooked at various temperatures; instead of or in addition to the cooling, it can also be frozen.

An important feature of the present invention is the correlation of pH with the nature of the meat employed and preferably also with the nature of subsequent processing steps. For example, mechanically deboned meat (which is a common form of poor quality meat) will often have a pH within the range from 6.4 to 7.0; the exact pH will depend upon the level of bone phosphates in the meat. Using a raw meat mass having such a pH, it is not generally necessary to adjust the pH of the fibrous textured vegetable protein, since the relatively high pH of mechanically deboned meat will ensure that the final product will have a pH within the preferred range of from 6.2 to 6.4. In other words, the amount of inorganic salts in the raw meat mass dictates, to some degree, the level of pH adjustment required. Of course, if it is desired to produce a product having a pH slightly below the range from 6.2 to 6.4, a food grade acid may be added, however, this is not generally required.

In addition, the temperature at which the product is subsequently processed also preferably dictates the pH adjustment. In general, we prefer that the temperature of processing should vary inversely with the level of pH adjustment. For example, if a pasteurized meat product is to be prepared (this being processed at a temperature of, for example, from 150 to 180°F), the pH of the fibrous textured vegetable protein is preferably raised from its initial pH, which is generally from 5.0 to 5.2, to a value of from 5.4 to 5.8. If a product of a type which is to be fried or grilled, e.g. a sausage or ground meat-type product, is to be prepared, then the fibrous textured vegetable protein is preferably raised to pH of from 5.6 to 5.8. Where the product is to be retorted (which would generally take place at a temperature of from 220 to 250°F), then the pH of the fibres is adjusted to a value within the range from 5.2 to 5.6. These pH adjustments assume that the raw meat mass will have a pH of from 5.8 to 6.4 and apply to meats of non-fish origin. Where the raw meat mass has the pH outside this range or where the meat is of fish origin, other appropriate pH adjustments may be made. In general, with the pH adjustments proposed above, the final product will have a pH above 6.0, even if the raw meat mass and the fibrous textured vegetable protein have a pH below

6.0, because the heat-coagulable vegetable protein isolate will generally have a pH of from 6.9 to 7.4, most commonly about 7.3.

Where the raw meat mass is wholly of non-fish origin, e.g. if it is beef, pork, mutton, chicken or the meat of other birds, the final pH of the product should be within the range of from 5.8 to 6.4, preferably from 6.2 to 6.4. Where the meat is wholly of fish origin, e.g. tuna, the final product should have a pH of from 6.3 to 6.8, preferably from 6.5 to 6.8. Although mixtures of non-fish and fish meat are not generally desirable, where they are required for special purposes, the appropriate pH range may be calculated from the ranges given for products containing meat of wholly fish and of wholly non-fish origin, taking the range in proportion to the amounts of fish and non-fish. The appropriate range may be calculated as follows, where M represents the percentage of the total meat which is non-fish and F represents the percentage of the total meat which is fish:

$$\text{Lower pH limit} = \frac{(6.3F + 5.8M)}{100}$$

$$\text{Upper pH limit} = \frac{(6.8F + 6.4M)}{100}$$

Adjustment of the pH may be made, as appropriate, by the addition of any food-grade acid or alkaline material. Particularly preferred is a mixture of sodium carbonate and a phosphate buffer employed in an amount sufficient to represent about 0.65% by weight of the fibrous textured vegetable protein. A preferred phosphate buffer is that sold under the Trade Mark Nutrifos B by McAuley Edwards Limited of Baldock, Hertfordshire; this has approximately twice the buffering capacity of sodium tripolyphosphate.

The invention is further illustrated by the following Examples.

EXAMPLE 1

The ingredients employed were as follows (parts by weight):

Mechanically deboned meat	30.0
Beef flanks	20.0
Salt (NaCl)	1.0
Phosphate blend (pH 7.0—7.2)	0.3
Ice/Water	5.7
Protein filaments (Purina 200 at pH 5.0—5.2)	20.0
Fat emulsion (4 parts by weight beef fat, 4 parts by weight water, 1 part by weight Purina 500E heat-coagulable protein, 3% by weight based on the emulsion salt)	20.0
Purina protein 610 non-heat-coagulable	3.0
	100.0

First, the fat emulsion is formed by mixing the ingredients in a bowl cutter. After removing the fat emulsion, the meat was chopped in the same bowl cutter with the phosphate, salt and ice-water until it had reached a smooth consistency and the appearance of the gristle and fat layers from the beef flanks had been totally destroyed. The pH of the protein filaments was not increased because of the relatively high pH of the mechanically deboned meat and because the product was subsequently to be retorted. In a conventional two-arm ribbon blender, the emulsion and filaments were mixed together, after which the meat paste and subsequently the Purina protein 610 were added. The mix was passed through a mincer having a 1 inch perforated plate and then extruded from a sausage filler into a meat processing mould. After this, different examples of the material were solidified either by cooking to an internal temperature of 150°F, or by freezing to −20°C or, whilst being extruded, subjected to continuous microwave cooking to coagulate the meat and the heat-coagulable protein. The material, solidified in any of these three ways was diced to form cubes of the desired dimensions and then stored frozen. After this, the product is preferably cooked by retorting. The product had a final pH of 6.2—6.4 (the different samples produced varying because of the varying pH of the mechanically deboned meat) and had a good meaty texture with no fat separation.

Colour can be provided by addition of caramel solution.

EXAMPLE 2

The following ingredients were mixed together, processed and cooked as described in Example 1 (parts by weight):

Pork belly (60% visual lean)	50.0
Salt	1.0
Ice	5.0
Sodium nitride	0.005
Purina 200 protein filaments (pH 5.2)	20.0
Fat emulsion (5 parts by weight pork fat, 5 parts by weight water, 1 part by weight Purina 500E/620 heat-coagulable protein and 3% by weight salt)	22.0
Purina protein 610 (non-heat-coagulable)	2.0
	100.005

The product had a final pH of 5.7 and showed heavy fat separation. The texture was dry and tough and there was no integration of the fat and filaments.

EXAMPLE 3

The following ingredients were mixed and cooked as described in Example 1 (parts by weight):

Pork belly (60% visual lean)	49.7
Salt	1.0
Phosphate blend (pH 8.8)	0.3
Ice	5.0
Sodium nitrite	0.005
Purina protein filaments 200 (pH 5.8)	20.0
Fat emulsion (as Example 2)	22.0
Purina protein 610 (non-heat-coagulable)	2.0
	100.005

The formulation employed is identical with that employed in Example 2, except for the pH-raising ingredients in the meat and in the filaments. The product had a final pH of 6.3 and, unlike the product of Example 2, showed no fat separation and was succulent; it had a well integrated texture.

EXAMPLE 4

The process and ingredients employed in this Example were identical with those pH of the filaments was 6.0 and the final pH of the product was 6.5—6.6. In contrast with the acceptable product obtained in Example 1, the product of this Example was soft with a jelly-like texture, totally unlike the texture of beef; no fibrosity remained.

EXAMPLE 5

This Example illustrates the preparation of a product from which the fat emulsion has been omitted. The following ingredients were used (parts by weight):

Mechanically deboned meat	30.0
Beef flanks	29.0
Salt	1.0
Phosphate blend (pH 7.0—7.2)	0.3
Purina 200 filaments (pH 5.0—5.2)	20.0
Purina protein 500E (heat-coagulable)	2.2
Water/Ice	14.5
Purina protein 610 (non-heat-coagulable)	3.0
	100.0

The meat was comminuted in a bowl cutter with the salt, phosphate blend, water/ice and Purina protein 500E. The mixture was then mixed in a ribbon blender with the filaments and the Purina protein 610. The product was then cooked. When the cooked product was compared with the product of Example 1, it was found to be less succulent and the texture was gritty in the mouth. The filaments had not had the opportunity of absorbing fat and had not integrated well with the matrix.

EXAMPLE 6

This Example illustrates a product from which the heat-coagulable protein has been omitted. The following ingredients were employed:

Pork belly (60% visual lean)	49.7
Salt	1.0
Phosphate blend (pH 8.8)	0.3
Ice/Water	15.0
Pork back fat	10.0
Sodium nitrite	0.005
Purina filaments 200 (pH 5.8)	20.0
Purina protein 610 (non-heat-coagulable)	2.0

The pork belly was comminuted in a bowl cutter with the salt, sodium nitrite, phosphate blend and ice/water. After complete extraction of the salt-soluble meat proteins, the pork back fat was added and chopped in. The filaments were then mixed with the resulting mass in a ribbon blender, after which the Purina protein 610 was added. The product was then cooked.

There was considerable fat separation in the cooked product, unlike the product of Example 3. The cohesiveness of the matrix and the succulence contributed by the stabilized fat emulsion which made Example 3 so acceptable were missing when the heat-coagulable protein was omitted.

EXAMPLE 7

The procedure of Example 1 was repeated, except that the non-heat-coagulable Purina protein 610 was omitted. This resulted in water and fat separation when these were released by the poor quality meat upon cooking. As with any separation of ingredients from meat products, flavour and textural ingredients were also lost and the quality of the residual product was poor.

EXAMPLE 8

The procedure described in Example 1 was repeated, except that, when mincing the product, a mincer with 0.125 inch perforations was employed. This caused excessive cutting of the filaments, substantially destroying their fibrous nature, and the resulting cooked product did not have the textural chewiness normally associated with beef. It resembled more a comminuted chopped product.

EXAMPLE 9

Following the procedure described in Example 1, the following ingredients were mixed (parts by weight):

Tuna fish	50.0
Purina filaments 200 (pH 6.2—6.4)	20.0
Salt	1.0
Nutrifos F (pH 8.6)	0.4
Ice	7.0
Purina Protein 610 (non-heat-coagulable)	3.5
Spices	0.1
Fish oil emulsion (1 part by weight Purina protein 500E heat-coagulable, 4.5 parts by weight deodorized fish oil, 4.5 parts by weight water)	18.0
	100.0

The product was cooked. The final product has a pH of 6.5—6.6 and a good fishy flavour and texture.

WHAT WE CLAIM IS:—

1. A reformed meat product having a pH value which (i) where the meat is not of fish origin, is from 5.8 to 6.4, (ii) where the meat is of fish origin, is from 6.3 to 6.8, or (iii) where the meat is a mixture of fish and of non-fish origin is an average of (i) and (ii) in proportion to the weight ratio of non-fish and fish, which product comprises:

(a) a raw meat mass, the connective tissue, if any, of which has been substantially destroyed;

(b) an emulsion of fat, water and a heat-coagulable vegetable protein;

(c) fibrous textured vegetable protein; and

(d) a non-heat-coagulable vegetable protein.

2. A reformed meat product according to Claim 1, in which said meat is beef or pork.

3. A reformed meat product according to Claim 1, in which said meat is tuna.

4. A reformed meat product according to any one of the preceding Claims, in which said meat contains 20 to 60% by weight fat.

5. A product according to any one of the preceding Claims in which said fibrous textured vegetable protein is employed in an amount of from 15 to 30% by weight of the product.

6. A product according to any one of the preceding Claims, in which the fat in said emulsion is employed in an amount of about 50% by weight of the fibrous textured vegetable protein.

7. A reformed meat product according to any one of the preceding Claims, comprising from 20 to 70% by weight of said raw meat mass.

8. A reformed meat product according to any one of the preceding Claims, in which said fibrous textured vegetable protein is in the form of protein filaments.

9. A reformed meat product according to any one of the preceding Claims, additionally comprising from 0.5 to 2% by weight of salt.

10. A reformed meat product according to Claim 1, substantially as hereinbefore described with reference to any one of foregoing Examples 1, 3 and 9.

11. A process for preparing a reformed meat product according to Claim 1, which comprises forming an emulsion of fat, water and a heat-coagulable vegetable protein, mixing said emulsion, a raw meat mass (the connective tissue, if any, of which has been substantially destroyed), fibrous textured vegetable protein and a non-heat-coagulable vegetable protein, and, if necessary, before or after mixing adjusting

the pH of said emulsion and/or of said fibrous textured vegetable protein to the value required to produce a product having said pH value (i), (ii) or (iii).

12. A process according to Claim 11, in which said emulsion and said fibrous textured vegetable protein are first mixed to form a vegetable protein matrix and said matrix is then mixed with said raw meat mass and said non-heat-coagulable vegetable protein.

13. A process according to Claim 12, in which the pH of said fibrous textured vegetable protein is adjusted to a value from 5.2 to 5.6 and said reformed meat product is subsequently retorted.

14. A process according to Claim 12, in which the pH of said fibrous textured vegetable protein is adjusted to a value from 5.6 to 5.8 and the reformed meat product is subsequently grilled or fried.

15. A process according to Claim 12, in which the pH of said fibrous textured vegetable protein is adjusted to a value from 5.4 to 5.8 and the reformed meat product is subsequently pasteurized.

16. A process according to any one of Claims 11 to 15, in which pH adjustment is effected by addition of a mixture of sodium carbonate and a phosphate buffer.

17. A process according to any one of Claims 11 to 16, in which said raw meat mass has a fat content of from 20 to 60% by weight.

18. A process according to any one of Claims 11 to 17, in which said reformed meat product comprises from 20 to 70% by weight of said raw meat mass.

19. A process according to Claim 18, in which reformed meat product comprises about 50% by weight of said raw meat mass.

20. A process according to any one of Claims 11 to 19, in which the fat in said emulsion is employed in an amount of about 50% by weight, based on the weight of said fibrous textured vegetable protein.

21. A process according to any one of Claims 11 to 20, in which said heat-coagulable vegetable protein is employed in an amount of from 7.0 to 20% by weight, based on the weight of the fat in said emulsion.

22. A process according to any one of Claims 11 to 21, in which said non-heat-coagulable vegetable protein is employed in an amount of from 1 to 5% by weight of the reformed meat product.

23. A process according to any one of Claims 11 to 22, in which said non-heat-coagulable vegetable protein is employed in an amount of from 2 to 10% by weight of the raw meat mass.

24. A process according to any one of Claims 11 to 23, in which said fibrous textured vegetable protein is employed in an amount of from 15 to 30% by weight of the reformed meat product.

25. A process according to any one of Claims 11 to 24, in which salt is added in an amount of from 0.5 to 2% by weight of the reformed meat product.

26. A process according to Claim 11, substantially as hereinbefore described with reference to any one of the foregoing Examples 1, 3 and 9.

27. A reformed meat product when produced by a process according to any one of Claims 11 to 26.

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